CLAIMS

What is claimed is:

1. A low dead volume extraction column comprising:
   i) a column body having an open upper end for attachment to a pump, an open lower end for passing fluid into and out of the column body, and an open channel between the upper and lower end of the column body;
   ii) a bottom frit bonded to and extending across the open channel, the bottom frit having a low pore volume;
   iii) a top frit bonded to and extending across the open channel between the bottom frit and the open upper end of the column body, the top frit having a low pore volume, wherein the top frit, bottom frit, and channel surface define an extraction media chamber; and
   iv) a bed of extraction media positioned inside the extraction media chamber.
2. The low dead volume extraction column of claim 1, wherein the bottom frit is located at the open lower end of the column body.
3. The low dead volume extraction column of claim 1, wherein the bottom frit is less than 200 microns thick.
4. The low dead volume extraction column of claim 1, wherein the bottom frit has a pore volume equal to 10 % or less of the interstitial volume of the bed of extraction media.
5. The low dead volume extraction column of claim 1, wherein the bottom frit has a pore volume of 0.5 microliters or less.
6. The low dead volume extraction column of claim 1, wherein the extraction media comprises a packed bed of gel-type packing material.
7. The low dead volume extraction column of claim 5, wherein the gel-type packing material is selected from the group consisting of agarose and sepharose.
8. The low dead volume extraction column of claim 1, wherein the bed of extraction media has a bed volume of less than 20 microliters.
9. The low dead volume extraction column of claim 1, wherein the bottom frit is a membrane screen and the top frit is optionally a membrane screen.

10. The low dead volume extraction column of claim 8, wherein membrane screen comprises a nylon or polyester woven membrane.
11. The low dead volume extraction column of claim 1, wherein the extraction media comprises a gel-type chromatography bead.
12. The low dead volume extraction column of claim 1, wherein the extraction media comprises an affinity binding group having an affinity for a biological molecule of interest.
13. The low dead volume extraction column of claim 11, wherein the affinity binding group is elected from the group consisting of Protein A, Protein G and an immobilized metal.
14. The low dead volume extraction column of claim 1, wherein at the column body comprises a polycarbonate, polypropylene or polyethylene material.
15. The low dead volume extraction column of claim 1, wherein the first and second membrane filters are bonded to the column body by gluing or welding.
16. The low dead volume extraction column of claim 1, wherein the volume of the extraction media chamber is less than 20 microliters.
17. The low dead volume extraction column of claim 1, wherein the bed of extraction media has a dry weight of less than 2 mgs.
18. The low dead volume extraction column of claim 1, wherein the extraction media comprise an extraction bead selected from the group consisting of affinity beads used for protein purification, ion exchange beads used for protein purification, hydrophobic interaction beads used for protein purification, reverse phase beads used for nucleic acid or protein purification, agarose protein G beads used for IgG protein purification, and Hypercell beads used for IgG protein purification.
19. The low dead volume extraction column of claim 1, wherein the column body comprises a luer adapter, a syringe or a pipette tip.
20. The low dead volume extraction column of claim 1, wherein the upper end of the column body is attached to a pump for aspirating fluid through the lower end of the column body.

21. The low dead volume extraction column of claim 1, wherein the pump is a pipettor, a syringe, a peristaltic pump, an electrokinetic pump, or an induction based fluidics pump.

22. The low dead volume extraction column of claim 1 comprising:

i) a lower tubular member comprising the lower end of the column body, a first engaging end, and a lower open channel between the lower end of the column body and the first engaging end; and

ii) an upper tubular member comprising the upper end of the column body, a second engaging end, and an upper open channel between the upper end of the column body and the second engaging end, the top membrane screen of the extraction column bonded to and extending across the upper open channel at the second engaging end;

wherein the first engaging end engages the second engaging end to form a sealing engagement.

23. The low dead volume extraction column of claim 22, wherein the first engaging end has an inner diameter that matches the external diameter of the second engaging end, and wherein the first engaging end receives the second engaging end in a telescoping relation.

24. The low dead volume extraction column of claim 23, wherein the first engaging end has a tapered bore that matches a tapered external surface of the second engaging end.

25. A method for extracting an analyte from a sample solution comprising the steps of:

i) contacting the lower end of the column body of the extraction column of claim 20 with a sample solution containing an analyte and aspirating a quantity of the sample solution into the column, whereby the quantity of sample solution enters the bed of extraction media and the analyte is adsorbed by the extraction media;

ii) discharging the sample solution out through the lower end of the extraction column body;

iii) contacting the lower end of the column body with a desorption solvent and aspirating a quantity of the desorption solvent into the column, whereby the quantity of sample desorption enters the bed of extraction media and the analyte is desorbed from the extraction media into the desorption solvent; and

iv) discharging the analyte-containing desorption solvent out through the lower end of the column.

26. The method of claim 25, wherein the column is attached to a pump for aspirating and discharging fluid through the lower end of the column body and the pump is used to discharge the sample solution and analyte-containing desorption solvent from the extraction column.

27. The method of claim 25, wherein between steps (ii) and (iii) a quantity of wash fluid is aspirated into the column through the lower end of the column and then discharged out through the lower end of the column, thereby washing the bed of extraction media.

28. The method of claim 25, wherein the volume of desorption solvent aspirated into the column is less than 3-fold greater the interstitial volume of the packed bed of extraction beads.

29. The method of claim 25, wherein the quantity of desorption solvent is aspirated and discharged from the column more than once.

30. The method of claim 25, wherein the analyte is a biological macromolecule.

31. The method of claim 30, wherein the biological macromolecule is a protein.

32. The method of claim 31, wherein the analyte-containing desorption solvent is introduced onto a protein chip.

33. The method of claim 31, wherein the analyte-containing desorption solvent is introduced into a mass spectrometer.

34. The method of claim 31, wherein the sample solution is a hybridoma cell culture supernatant.